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4.1.2 Daylighting Design

Daylighting is the effective use of natural light in buildings to minimize the need for electric light during daylight hours. When properly designed, daylighting can provide high-quality architectural lighting and can balance the thermal consequences of additional glazing. Since many Federal buildings use significant energy for electric lighting (often 30 to 50% of annual energy use), daylighting can be a very important design strategy to consider.

Opportunities

In almost all cases where lighting is needed in a building on a regular basis during the day, daylighting can be an effective solution for at least some of the lighting requirements. Daylighting should be considered in buildings such as offices, laboratories, schools, food service facilities, and other daytime-use spaces. In existing buildings, daylighting potential is greatest close to perimeter window walls.

A baseline lighting profile will help establish the potential opportunities for daylighting. The graph below illustrates the lighting profile baseline of an office building on average days for each month on a 24-hour basis. The energy saved because of daylighting is plotted in the lower negative curve. This profile indicates that daylighting provides considerable savings in this building and thus is a good candidate for further consideration.

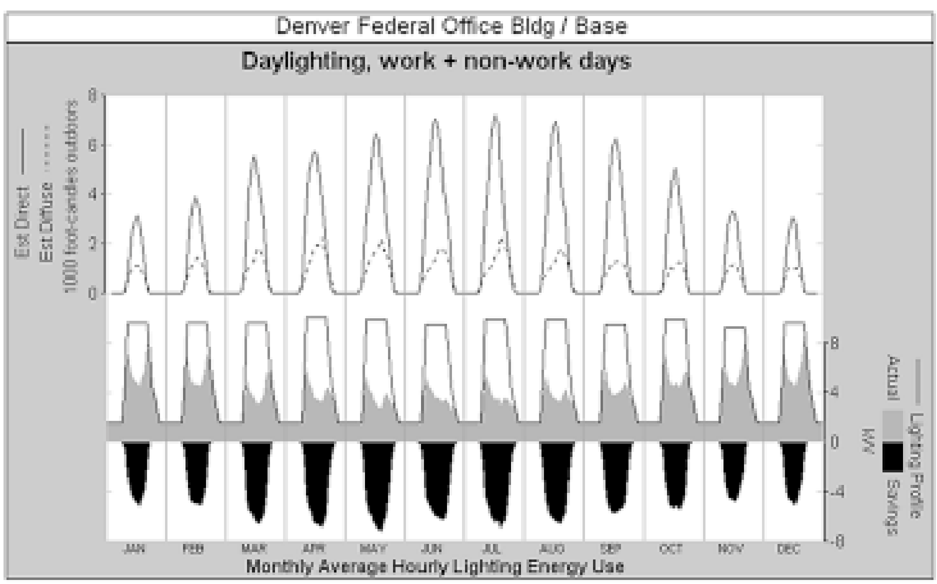
Achieving good daylighting is often more of an art than a technical, engineered solution. The eye's perception of light is a key part of visibility. The amount of light (typically measured in foot-candles) in a space is only one small part of the equation. The brightness of surfaces within the field of view directs the eye's perception of visibility. If the brightness difference (luminance ratio) of surfaces being viewed is too great, the darker areas seem underlit even when the amount of light is within desirable ranges.

The quality of daylight and the human need for connection to daylight cannot be emphasized enough. Human health and productivity can be enhanced with sound daylighting designs. Some studies have indicated significant increases in productivity (up to 15%) and reduced absenteeism for office workers through the use of effective daylighting. Recent studies in California demonstrate a strong statistical correlation between daylighting and improved sales in retail stores. Similarly, daylit classrooms are being shown to result in faster learning and healthier students.

The form-givers relating to daylighting design are building geometry (architectural form of interior spaces and the building as a whole), glazing strategies (size, orientation, type, location), daylighting controls (light shelves, blinds, fins), and surfaces (textures, colors). A double-loaded corridor provides access to daylight from one wall in each room, with a lower level of borrowed light in the central corridor.

Technical Information

Windows are provided in most buildings for daylight, view, and architectural aesthetics, as well as to satisfy a basic human need to connect with nature. However, the art and science of designing effective, high-quality daylighting systems goes beyond simply adding windows in a wall. Glazing strategies responding to size, location, orientation, type, sun control, and building geometry all affect the quality and effectiveness of a daylighting design.



The energy saved monthly as a result of daylighting in a Denver Federal office building is shown graphically in the bottom (black) profiles. Source: ENSAR Group

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There is a tremendous amount of light outdoors, and even small windows let in enough light—an important objective is to minimize the difference between the lightest and darkest points of the room.

A key component of any daylighting strategy, particularly for a large building, is careful integration with electric lighting. After all, even the best daylighting design will save energy only if it reduces the amount of electricity used for artificial lighting. Daylight controls can dim fluorescent lighting if luminaires are fitted with dimming electronic ballasts. Controlling banks of luminaires along window walls separately from interior lights enables perimeter lights to be dimmed when natural light levels are adequate, thus yielding significant savings.

Beyond the basics, advanced daylighting systems, such as light pipes, light shelves with specular surfaces for deep directional daylighting to the building core, fiber optics, tracking daylight apertures, and other techniques can provide ample daylighting when simple approaches won't solve the problem. Most of these approaches, however, will increase overall costs.

Bring daylight in high in the space, bounce daylight off surfaces, filter daylight with vegetation and architectural components, and integrate daylighting design with electric lighting, HVAC, and architectural systems.

Avoid ceiling reflections and direct sunlight or skylight in areas where extreme brightness isn't useful.

References

Evans, Benjamin H., AIA, *Daylight in Architecture*, McGraw-Hill, New York, NY, 1981.

Ander, Gregg D., AIA, *Daylighting: Performance and Design*, Van Nostrand Reinhold, New York, NY, 1995.

Source: ENSAR Group

Building 33 at the Navy Shipyard in Washington, D.C., is a retrofit of a historic building where daylighting was employed through skylights and windows.

Contacts

Windows and Daylighting Group, Lawrence Berkeley National Laboratory, Berkeley, CA; 510/486-6845, www.lbl.gov. *Tips for Daylighting with Windows* is available as a pdf file.

Center for Buildings and Thermal Systems, National Renewable Energy Laboratory, Golden, CO; www.nrel.gov/buildings_thermal/.

Daylighting Collaborative, Energy Center of Wisconsin, 595 Science Drive, Madison, WI 53711; (608) 238-4601; www.daylighting.org.

Pacific Gas & Electric Daylighting Initiative, www.pge.com/pec/daylight/.